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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

# Operations Guidance Report on

# WATER FACILITIES FOR NORTH CANADIAN RIVER WATERSHED IN BEAVER COUNTY OKLAHOMA

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

September 1939

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# NORTH CANADIAN RIVER WATERSHED
# IN BEAVER COUNTY
# OKLAHOMA

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DIVISION OF LAND ECONOMICS

Under the Provisions of the
Water Facilities Act
(Public Law No. 399, 75th Congress)

September 1939

# ACKNOWLEDGMENTS

This report has been prepared by the Water Utilization Section, Land Economics Division, Bureau of Agricultural Economics. The base map of the area was compiled in part from original field reconnaissance and in part from the base sheets of the Oklahoma State Highway Department. Geologic data were obtained from the United States Geological Survey base map and Bulletin No. 40, Volume 2, published by the Oklahoma Geological Survey. Climatological data were obtained from publications of the United States Weather Bureau. Land use and economic data were obtained from Beaver County officials.

# AUTHORIZATION

This report has been prepared under the provisions of the Water Facilities Act, Public Law No. 399, of the 75th Congress. The Water Facilities Act authorized the Secretary of Agriculture to formulate a program for the development of small water facilities and further authorized the Secretary of Agriculture to assign responsibility for operation of the Program.

In a memorandum from the Secretary dated July 1, 1939, responsibility for the preparation of area plans for specific areas selected by the Water Facilities Board was assigned to the Bureau of Agricultural Economics.

The Water Facilities Board approved for planning an area which includes all the land south of the Beaver River in Beaver County, Oklahoma.

This report has been prepared subject to the authority and responsibility assigned to the Bureau of Agricultural Economics.

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**Geology and Availability of Ground Water**

## CONCLUSIONS AND RECOMMENDATIONS

1. The average annual precipitation at Beaver, in the north central part of the area, is 18.81 inches.
2. The estimated average annual surface run-off per square mile is 18 acre-feet over areas of Tertiary outcrop, and 40 acre-feet over areas of "red bed" outcrop.
3. The principal water bearing formations are the Tertiary sands and gravels, and Quaternary alluvium.
4. Ground-water development for both stock and domestic purposes is recommended in areas of Tertiary and Quaternary outcrop.
5. Ground-water development in the "red bed" areas is recommended for stock purposes only.
6. It is recommended that ground-water development for irrigation purposes in the alluvium area along Beaver Creek be delayed, pending results of court action stated on page 14 of this report.
7. The "red bed" areas offer no pump irrigation possibilities.
8. It is recommended that surface water development be limited to the following:
    - a. Construction of small dams and reservoirs for stock watering purposes and garden irrigation.
    - b. Flood irrigation of the better soil type native pastures.

## PURPOSE AND SCOPE

The purpose of this report is to indicate in a preliminary manner the agricultural utilization of the available water resources.

The data contained in this report are the result of reconnaissance studies. While additional information would allow recommendations to be made in greater detail, it is believed that the recommendations herein contained are reliable and have sufficient accuracy for the purpose of pointing the direction which the action program should take.

Proposed and recommended developments are outlined and discussed in their relation to the best utilization of the available water resources in the area.

# DESCRIPTION OF THE AREA

## Location

The area discussed in this report is located in Beaver County, which is the easternmost county of the Oklahoma Panhandle. It includes all the land in the county south of the Beaver River (North Canadian) which amounts to 1,065 square miles or 681,600 acres. It lies between 36°30' and 36°50' north latitude and 100°00' and 101°00' west longitude. The principal tributaries to the Beaver are Clear, Six Mile, Duck Pond, Kiowa, Willow, Jackson and other small creeks. The principal town in the area is Beaver, the county seat of Beaver County. Other small, unincorporated towns in the area are Elmwood, Gray, Logan, Balko, Como and Clear Lake.

The North Canadian River is known locally as the Beaver River and will be referred to by that name throughout this report.

## Topography

Beaver County, of which this area is a part, is essentially a rectangular block, cut out of the High Plains, with its greater dimension running east and west. It is located in

the Plains Border Section of the Great Plains Province, described by physiographers as a "submaturely to maturely dissected plateau." The land surface of the county in general slopes gently to the east, however, the specific area for which this report is prepared includes only that part of the county lying south of the Beaver River. The land surface of this area slopes gently to the northeast.

The topography of the area may be divided into three types; namely, uplands, breaks and valleys. The unevenness of the surface of the area has been the result of erosion by water and the cutting by streams, this action creating the many valleys, large and small, which now interrupt the flat surface of the original plain.

The southern part of the area is essentially a broad upland, gently rolling to rolling, the surface of which slopes north and northeast toward the valley of Beaver River --- where it eventually becomes undulating. In the northern part of the area many tributaries to the Beaver River have eroded through the Tertiary mantel and exposed the Permian "red beds," giving rise to a rough and broken topography.

## Elevations

The elevations above sea level of the points where the Beaver River enters and leaves the area are approximately 2,600

and 2,150 feet, respectively. The elevation of the town of Beaver is 2,500 feet above sea level, and that of the Beaver River nearby, is 2,420 feet. South of Gray, near the Texas-Oklahoma line, the elevation is approximately 3,400 feet above sea level.[1]

## Drainage Pattern

Beaver River is the principal stream in the area. Traversing the area, it first flows in a northeasterly direction, thence east across the area, a distance of approximately 55 miles. It is a typical plains stream, having a broad, sand filled channel, and low sand banks. The width of the channel from bank to bank averages about 200 yards.[2]

Many tributary streams empty into the Beaver from the south. The majority of these streams originate on the relatively flat upland in the southern part of the area, and flow north and northeast to their confluences with the Beaver. The more important streams flowing northward into the Beaver are Jackson, Willow, Elm, Six Mile, Home, Clear, Camp and Duck Pond creeks. Kiowa Creek flows northeasterly into Harper County where it unites with the Beaver.

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[1] Elevations secured from House Document No. 308, 74th Congress, Report on Arkansas River, Corps of Engineers.

[2] Gould, Charles N., and Lonsdale, John T., Geology of Beaver County, Oklahoma, Okla. Geol. Survey, Bull. No. 38, p. 16.

## Climatological Data

The monthly and annual average precipitation at Beaver, Oklahoma, is shown in the following table. This record is for a period of 33 years.

Beaver, Oklahoma
Average Monthly and Annual Precipitation
in Inches
Elevation - 2,500 feet

| J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .41 | .77 | .97 | 1.77 | 2.54 | 2.70 | 2.10 | 2.35 | 2.16 | 1.39 | .93 | .72 | 18.81 |

## Geology and Ground Water Resources

The geology of the area is not complex. Surface formations are few in number and simple in arrangement. The following table is a summary of the formations outcropping over the area, and their general lithologic characteristics:

| Age | Formation | - Lithology - |
|---|---|---|
| Quaternary | ---- | Alluvium |
| Tertiary | ---- | Loosely consolidated sands, gravels, clays and conglomerates |
| Permian | Cloud Chief | Chiefly red shales with interbedded layers of gypsum |

Cloud Chief Formation.--The Cloud Chief is one of several formations which together comprise the widespread Permian "red beds."

These formations underlie all of the area, however, the Cloud Chief is the only one appearing at the surface. The outcrops are confined in the northern part of the area along the lower drainage courses of the principal tributaries of the Beaver River. In these areas, the streams have eroded through the Tertiary mantel and exposed the underlying Cloud Chief.

This formation consists of red shales, and sandy shales, interbedded with layers of gypsum. Similar to other "red bed" formations, it yields only small quantities of highly mineralized water, rarely suitable for domestic purposes, but generally acceptable for stock purposes.

Tertiary Sands and Gravels.—These rocks, as shown on the accompanying map, cover practically the entire surface of the area. In general, the Tertiary consists of a heterogenous mixture of clays, sands, and gravels, which were laid down on an uneven land surface. The source of the rocks was from the west, hence they thin to the east. The average thickness of the Tertiary over the area is not known in view of the erosional unconformity between it and the underlying rocks, and the scarcity of reliable well log data. It is known, however, that much of the Tertiary once present in this area has since been removed by erosion.

The Tertiary rocks comprise one of the chief sources of ground water in the area. Numerous wells are at the present time producing water from this source in sufficient quantities and of a satisfactory quality for both stock and domestic requirements.

The quality varies only slightly, from place to place, however, the yielding capacity of wells produced from these rocks is quite likely to vary considerably. This condition is the result of differences in permeability and porosity of the formation in general, due to the manner in which the various materials comprising it were deposited, and to local cementation by lime.

Likewise, the depths of wells producing from the Tertiary vary greatly, ranging from 10 to 250 feet. This is the result of numerous "perched" water tables lying above the main water table. These "perched" tables are caused by local shale members or other relatively impervious rocks which interfere with the downward movement of water enroute to the main water table. Hence, it is not always possible to predict the depth of wells.

No data are available regarding the slope of the water table in the Tertiary. However, the water contained therein is "free water," and in such cases, the slope of the main water table usually conforms roughly with the land surface.

The source of ground water in these rocks is from local precipitation.

Quaternary Alluvium.—The greatest amount of alluvium in the area occurs in the valley of Beaver Creek as shown on the accompanying map. Alluvium also covers a small area along the valley of Kiowa Creek in the northeastern part of the area. In both areas, the alluvium yields water of a satisfactory quality in quantities sufficient for stock and domestic requirements.

The materials comprising these alluvium deposits have been derived from both the Tertiary and Permian deposits, the latter probably having contributed much fine material in the form of clay. The thickness of the alluvium from place to place is unpredictable. It is quite possible that these deposits will yield sufficient water for irrigation, however, this development is contingent upon the amount of irrigable lands.

## Ground Water Discharge

Numerous springs occur along the channels of the tributaries to Beaver Creek. The springs are chiefly contact in nature, the water issuing from Tertiary or Quaternary deposits at their contact with the underlying "red beds." Kiowa, Camp, Duck Pond, Clear, Willow and Jackson are partly fed by these springs.

Surface water resources.—The average annual discharge of the North Canadian River at Woodward, Oklahoma, approximately 80 miles southeast of the center of the area, is about 215,000 acre-feet. The estimated average annual discharge of the North Canadian River (Beaver Creek) at Gate, Oklahoma, which is adjacent to the northeastern part of the area, is about 100,000 acre-feet.[1] The drainage areas above Woodward and Gate are 10,680 and 7,860 square miles, respectively. These figures result in a unit run-off of approximately 20 acre-feet at Woodward and 13 acre-feet at Gate. In view of the heavy seepage losses incurred in the sands and

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[1] Arkansas River and Tributaries, Corps of Engrs., U. S. Army, House Doc. 308, 74th Congress, 1st Session, p. 1053.

alluvium along Beaver Creek, it is reasonably certain that the unit run-off over the general area will exceed 13 acre-feet. No discharge records are available for any of the tributary streams of the Beaver in the area. An estimated unit run-off of 18 acre-feet per square mile of drainage area is believed to be conservative and consistent with the available data.

In local areas, where Permian "red beds" form the land surface, the unit run-off will be considerably higher. Based upon discharge records of the Washita River at Clinton, Oklahoma, surface run-off from the "red bed" areas approximates four per cent of the average annual precipitation.[1] Assuming this relation to exist in this area, the average annual run-off per square mile of "red bed" drainage area would be approximately 40 acre-feet.

## Land Use

It is estimated that approximately 55 per cent of the land is given to cropping practices, and the remainder is in native pasture. A negligible percentage is abandoned. The average farm unit contains about 400 acres. The majority of these units are classified as satisfactory in regard to the proportionate division of range and cultivated lands. Land use has been given more than

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[1] Records not available for publishing.

average consideration in this area, and on the majority of farms, cultivated land has been equally divided between feed crops and cash grain crops. The average unit maintains a small herd of both milk and beef cattle, as well as a substantial flock of poultry.

# PROPOSED UTILIZATION

## Stock and Domestic

It is recommended that surface water development over the entire area be limited to the construction of small reservoirs for stock watering purposes, and to flood irrigation of the better soil type native pastures. Care must be exercised in selecting impounding sites in the "red bed" areas because of the gypsiferous Cloud Chief formation.

Ground water development for both stock and domestic purposes is recommended throughout all areas of Tertiary and Quaternary outcrop. Throughout the "red bed" areas, ground water development is recommended for stock purposes only, in view of the poor quality of "red bed" water.

## Irrigation

Present knowledge regarding physical conditions does not indicate the feasibility of any large scale pump irrigation from the Tertiary deposits. The entire area has been eroded out of the High Plains, and, as a result of which, much of these deposits have been removed. The average thickness of the Tertiary over the area is not known, however, it is reasonable to believe that it is

comparatively thin. Furthermore, the majority of the tributaries to the Beaver have eroded through the remaining Tertiary and exposed the Permian "red beds" over rather large areas. This condition has resulted in the development of numerous contact springs, all of which tend to drain the Tertiary deposits of their water supplies. There are no available data regarding the hydraulic records of wells or physical characteristics of the deposits. Summarizing the above considerations, pump irrigation from the Tertiary deposits cannot be justly recommended at the present time.

Occurring along Beaver and Kiowa creeks are deposits of alluvium which have been discussed under "Geology." These deposits, the more extensive of which occur along Beaver Creek, are recharged through influent seepage along the main stream channels, and, will possibly yield water in quantities sufficient for irrigation purposes. Irrigable land will be the limiting factor regarding irrigation in these alluvium areas. In view of this fact, it is therefore recommended that ground water in the alluvium along Beaver Creek be developed for irrigation purposes wherever land conditions permit. It is further recommended that an annual recovery rate in excess of 130 acre-feet per square mile should not be contemplated until after withdrawal at the given rate for a period of years has shown that additional recovery can be made without a continuous lowering of the water body. It is further recommended that wells be spaced at least one-quarter mile apart.

Water resources of the North Canadian (Beaver) watershed are soon to be subject to court action, instigated by Oklahoma City, Oklahoma, concerning the city supply. It is therefore recommended that any irrigation development in this area be delayed, pending the results of this suit.

The "red bed" areas offer no possibilities for pump irrigation.

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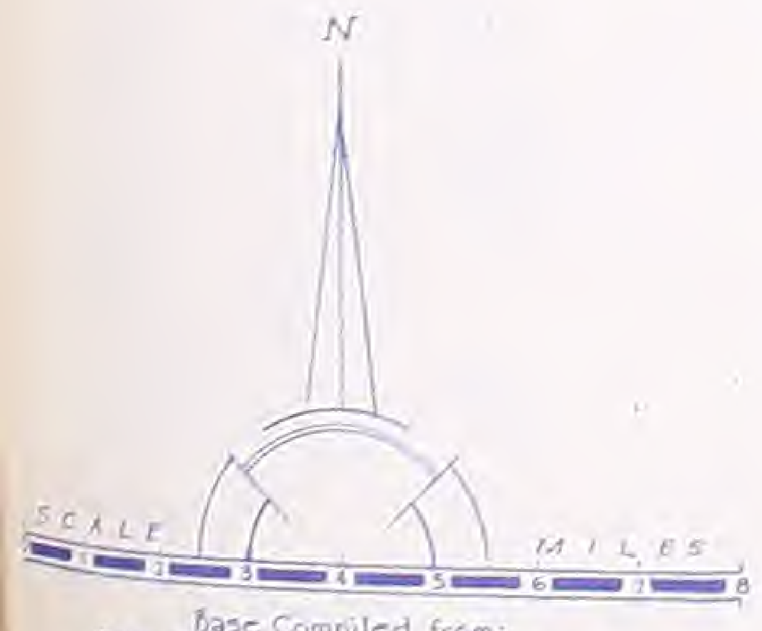

Base Compiled from:
Okla State Highway Dept. Base
sets & Original Field Reconnaisance

L E G E N D

| Sedimentary Rocks | | | Availability of Ground Water |
|---|---|---|---|
| Quaternary | Qal | Alluvium | Potable Groundwater readily recoverable in quantities for stock & domestic purposes. |
| Tertiary | Tl | Late Tertiary deposits | |
| (Permian) | Ccc | Cloud Chief Gypsum | Ground water generally available in sufficient quantities for stock purposes. Unfit for domestic uses. |

# BEAVER CO. OKLA. AREA
## GEOLOGY AND AVAILABILITY OF GROUND WATER

Prepared By
WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS
Under the Provisions of
The Water Facilities Act, Public
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